



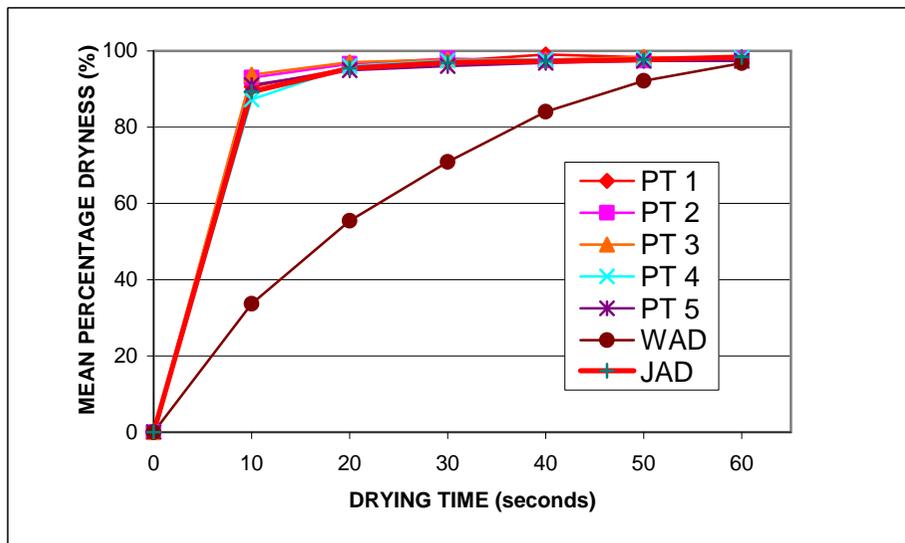
European Tissue Symposium (ETS), Brussels
A comparative study of different hand drying methods:
paper towel (PT), warm air dryer (WAD), jet air dryer (JAD).

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The study was performed in 4 parts (A – D):

Part A: The drying efficiency of different hand drying methods.

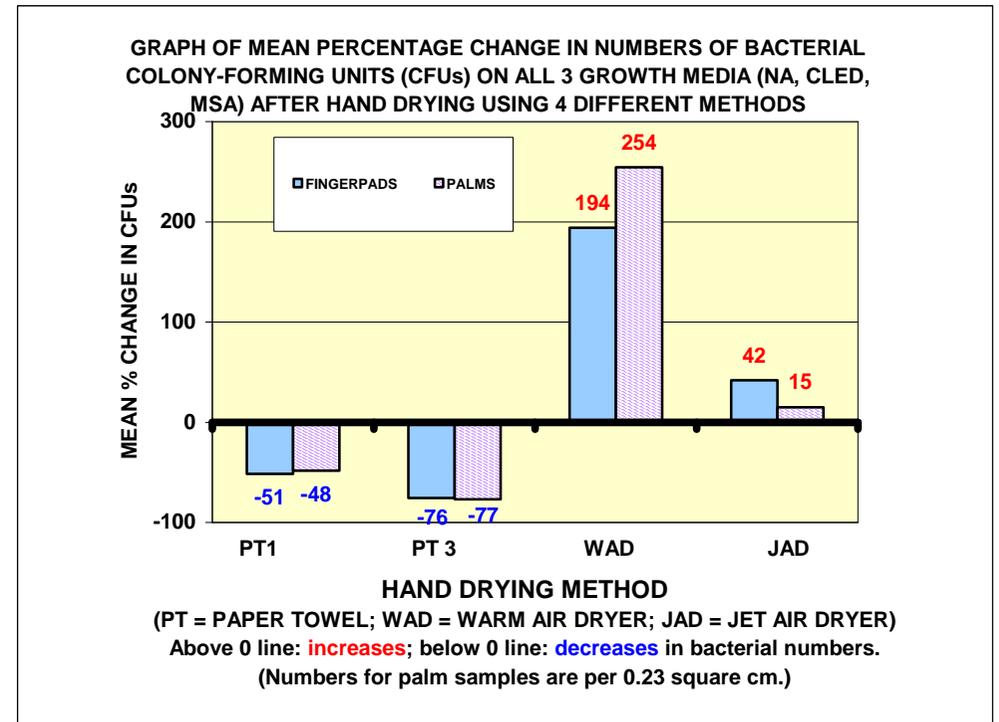
The average amount of water remaining on the hands of volunteers after using three hand drying methods (paper towel, warm air dryer, jet air dryer) for different times (0 – 60 seconds) was measured and the percentage dryness at different times and using different methods was calculated. The measurements were repeated and the means used.



The jet air dryer (JAD) had a drying efficiency equal to that of the 5 types of paper towel (PT 1 - PT 5) tested and, like them, achieved at least 90% dryness in approximately 10 seconds. The warm air dryer (WAD) took an average of 47 seconds (over 4-times as long) to achieve 90% dryness, *i.e.* was slower than the jet air dryer or the paper towels at drying the hands.

Part B: Changes in the number of different types of bacteria on the hands before and after drying using paper towel, warm air dryer and jet air dryer.

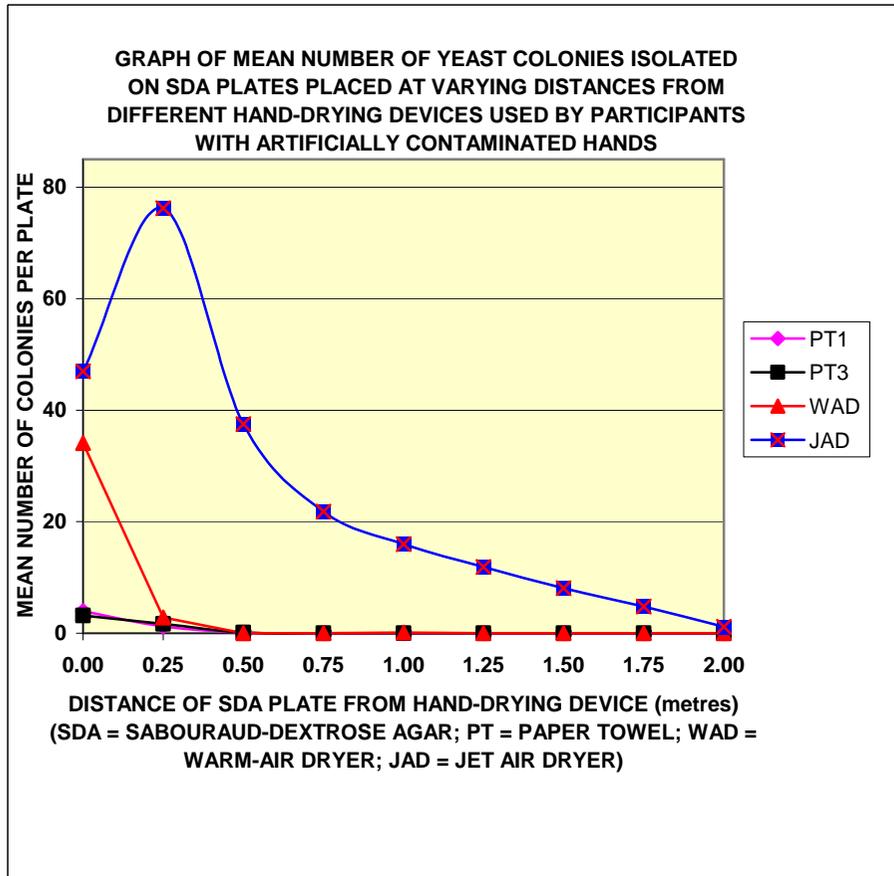
After visiting a washroom, the fingerpads and the palms of the hands of 20 volunteers were sampled before and after washing and drying using paper towel, warm air dryer, and jet air dryer. Combined results of the bacterial counts on three different bacterial growth media (Nutrient Agar [NA], Cystine-Lactose-Electrolyte Deficient [CLED], and Mannitol Salt Agar [MSA]) are shown below.



The two types of paper towel (PT 1 and PT 3) tested produced mean decreases in all types of bacteria tested after washing and drying of the hands. The decreases were respectively -51% (from 3908 to 1899) and -76% (from 3402 to 829) for the fingerpads and -48% (from 1388 to 716) and -77% (from 1286 to 298) for the palms. The warm air dryer (WAD) produced a mean increase in all types of bacteria tested on the fingerpads by +194% (from 2460 to 7231) and the palms by +254% (from 993 to 3520) of the hands after use. Although the JAD performed better than the WAD, it did not perform as well as the paper towels and did not on average reduce the numbers of bacteria on the hands after use but increased them on the fingerpads by +42% (from 3659 to 5195) and on the palms by +15% (from 1897 to 2179). Except for the JAD/palm one, changes in numbers of bacteria were significant at $p = 0.1$ or lower. **PTO**

Part C: Potential contamination of other users and the washroom environment caused by paper towel, warm air dryer, and jet air dryer.

In this part of the study the hands of 10 subjects were artificially contaminated with yeast suspension. Subjects then dried their hands using paper towel, warm air dryer or a jet air dryer for set times (10 seconds for paper towel and JAD; 20 seconds for WAD). Yeast was detected at different distances from each hand drying device by growth of colonies on Sabouraud-dextrose agar (SDA) plates.



The results showed that the jet air dryer (JAD) dispersed the artificial contamination on the hands for distances of up to 2.00 metres. The paper towels (PT) performed better than the warm air dryer (WAD) directly below the device but both hand drying methods showed no significant dispersal beyond 0.25 metres, unlike the jet air dryer. The capacity of a hand drying device to disperse artificial contamination demonstrates its potential to disperse actual contamination from the hands to other users and the washroom environment.

Part D: Bacterial sampling of jet air dryers in public washrooms.

The surfaces and air flows of 16 dryers were sampled in the male and female washrooms of a main line London railway station on different days and times.

SOURCE OF BACTERIA	IDENTIFICATION	NUMBER SAMPLES TESTED	NUMBER POSITIVE SAMPLES	% POSITIVE
Human skin, hair, nose	<i>Staphylococcus aureus</i>	112	80	71
	Other <i>Staphylococcus</i> species	112	105	94
Human gut, faeces	<i>Escherichia coli</i>	112	26	23
	<i>Klebsiella</i> species	112	11	10
	<i>Serratia marcescens</i>	32	1	3
	<i>Hafnia alvei</i>	48	1	2
Water, soil	<i>Enterobacter</i> species	80	2	2
	<i>Pseudomonas aeruginosa</i>	112	24	21
Various	<i>Bacillus</i> species	64	24	38
	<i>Chryseobacterium meningosepticum</i>	48	1	2
	<i>Chryseobacterium indologenes</i>	48	2	4
	<i>Pasteurella pneumotropica</i>	48	1	2

Bacillus species are common environmental contaminants but some of the other bacteria isolated from jet air dryers in public washrooms are potential pathogens (disease-causing) and/or indicators of faecal or other types of contamination. The mean bacterial numbers per square centimetre ranged between 85 and 171 on the inner surfaces and slits of the jet air dryers and between 4745 and 7537 at the bottom of the hand drying chamber. Counts of a 10-second air sample ranged between 10 and 20 colonies per agar plate.

Overall conclusions The jet air hand dryer (JAD) showed equal drying efficiency compared to the paper towels tested, and better than the warm air dryer (WAD). Its hygiene performance compared to a WAD was better in terms of smaller mean increases in the numbers of bacteria on the hands after use but worse than the paper towels, which both reduced the numbers. The JAD dispersed artificial contamination on the hands further than the WAD or paper towels. Bacteria, including potential pathogens, were detected in the air flows and on the inner surfaces, particularly the bottom, of jet air dryers in public washrooms. The results of this study suggest that the use of electric hand dryers (both WAD and JAD) should be carefully considered in locations where hygiene is paramount, such as hospitals, clinics, schools, nurseries, care homes, kitchens and other food preparation areas.

Note: this study has not been peer reviewed and this document is a summary only of the main findings.